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## MODERN SAFETY SYSTEMS FOR WORK AT HEIGHT

### NOWOCZESNE SYSTEMY ZABEZPIECZEŃ BHP PRZY ROBOTACH NA WYSOKOŚCI

#### Abstract

When organising work at height, the site manager has a duty to provide adequate security measures which will ensure safe working conditions. The correct criteria adopted to ensure the safe movement of equipment and materials and the safe implementation of all professional activities by all employees. This paper attempts to identify and describe systems set up to protect against falls from height, without the use of scaffolding, employed in today's construction market.

*Keywords: work at height, personal protection measures, collective protection measures*

#### Streszczenie

Przy organizowaniu pracy na wysokości kierownik budowy ma obowiązek zapewnić odpowiednie środki ochrony, które zagwarantują bezpieczne warunki pracy. Właściwie przyjęte kryteria zapewnią bezpieczne przemieszczanie i wykonywanie wszelkich czynności zawodowych przez wszystkich pracowników. W niniejszym artykule podjęto próbę wskazania i opisu obecnych na rynku budowlanym nowoczesnych systemów chroniących przed upadkiem z wysokości, bez użycia rusztowania.

*Słowa kluczowe: praca na wysokości, środki ochrony indywidualnej, środki ochrony zbiorowej*

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## 1. Introduction

Construction still remains one of the most dangerous industries in Poland. Safety standards and compliance with safety rules still leave much to be desired. In the past year, according to the Central Statistical Office, there have been 99 deaths on construction sites in Poland, three times more than in the mining industry which was once at the forefront of this infamous ranking. Accidents are generally caused due to a lack of appropriate staff qualification, safety violations and cost cutting on safety. To change the number of accidents on construction sites and minimise their cause, a single action is not sufficient. There is a need for long-term measures to change the mentality, awareness, attitudes and habits of employees and employers. This also entails some investment, but not so great as to be the main issue in failing to implement such measures.

One particularly dangerous type of work is work at height, or any workplace where workers are at a height of 1m or more from the ground, where the height is calculated from the plane on which the employee is standing [2]. Work at height does not include work on the surface, regardless of the height, at which it is located, if this surface is:

- Enclosed on all sides to a height of at least 1.5 m with full walls or walls with glazed windows;
- Equipped with other permanent structures or devices for protecting workers against falls from a height [2].

The preparation of proper protection is often cumbersome – take a lot of time to set up, while at the same time the material cost also escalates. It is therefore often worth taking advantage of commercially available ready-made systems of collective protection. Investment in the practical application of security systems begins before the commencement of works, using a detailed design. All dangerous areas are highlighted and effectively safety designed in, in order that all the necessary work can be carried out safely and as planned without loss of time taken to eliminate hazards while the job is in progress and most importantly, without prejudice to the health and life. This paper attempts to identify and describe currently available in the market modern systems protecting against falls from a height, without the use of scaffolding.

## 2. Health & safety regulations in the light of Polish law

The provisions of the EU directives on health and safety during construction works are included in the Polish building law and legislation. Additional obligations have been imposed on the legal participants in the construction process.

### 2.1. Principles of working at height

Working at height has been classified as high risk, and is permissible only if the risks in the workplace are reduced to an acceptable level. The following conditions must be met in order for a worker to perform work at height [1]:

- Employee has a valid medical test permitting work at height,
- Employee has a valid health and safety training for working at height,
- The work is done by at least two people,

- Employee has been trained by a representative of the employer at the workplace (workplace training),
- Employees are provided with personal protective equipment to protect against falls from a height,
- The facility and pathways to the workplace are properly secured and have valid technical approval (if required),
- Employee has read the plant instructions and the job instructions related to the work performed,
- Employee is informed and made aware of the risks arising from work at the given workplace,
- The facility has a solid safety system, enabling the continuity of protection.

Employee cannot perform work at height in adverse weather conditions: during a storm, at night, with strong winds in excess of 10 m/s, in very cold weather in excess of  $-15^{\circ}\text{C}$ .

## 2.2. Fall from height

Each employee performing work at height must be protected from falling. This obligation also applies, to the passageways and access paths to the workplaces, staircases, holes in ceilings and other locations accessible to people where there is a risk of falling from height. Choosing a method for protecting workers from falls from height, in the first place, we use collective protection measures such as railings, protective scaffolding. If the use of collective protection measures is not possible, personal protective equipment must be used, such as harnesses, mansafe, etc.

Falls from height are the most common cause of injuries and fatalities at work. Risk of falling from a height occurs at a height of 1 m or more from the ground, unsecured without appropriate means of collective protection or without the use of required personal protective equipment:

- It is possible to access the unprotected edge of [1]:
  - Excavation,
  - Stairs, platforms and bridges,
  - Floors, mezzanines and balconies,
  - Roofs,
  - Technological holes in ceilings,
  - Open inspection chambers, telecommunication manholes, etc.;
- The work is carried on:
  - Ladders,
  - Scaffolding,
  - Poles, masts, chimneys, building structures without ceilings,
  - From chairlifts, rope ladders or mobile working platforms,
  - Incomplete workplaces, in poor condition, improperly secured and not admitted to use by authorised persons;
- There is an abnormal ascending or descending to/from the workplace:
  - On structural elements of scaffolding,
  - On excavation struts,
  - Transport of workers in devices not intended for this purpose.

The organisation of safe working at height is the perfect embodiment of fulfilling the principle of the primacy of collective protection measures before individual protection

equipment. When selecting the appropriate technology for the job, construction management should also consider solutions that enable the protection of employees without the use of personal protective equipment. Examples of such solutions is the use of hoists, scaffolding and working platforms. These feature permanent barrier protection against falls from height. Employees can freely perform the work and do not have to remember to reconnect personal protective equipment for each change of location.

There are many available measures and methods of collective employee protection, for example: railings, protective nets and protective scaffolding. However, to apply them effectively, it is necessary to plan beforehand, select methods and prepare the facility. Sometimes it is not possible to fully protect workers through the application of collective protection measures. In such a situation, personal protection equipment is used. These are selected after an analysis of risks and conditions in the workplace. The most common personal protection equipment against falls from height is a safety harness with a cord and shock absorber or self-locking device.

### 3. Modern protection systems against falls from height

The article presents a modern system of collective protection to prevent falls from height, without the use of scaffolding:

#### 3.1. Collective protection measures – SECUMAX system

SECUMAX system is a system of protective railings designed to be used as lateral protection on the edges of buildings and excavation, protection against falls from height (Fig. 2). The system has the features and meets the requirements of strength for the class A according to PN-EN 13374 – “Temporary protection systems at the edge of the buildings – Technical description of the product, test methods”. According to the above standards:

- Class A – defines the system resistant to static load protecting people leaning against the system or using the system as a handrail while walking along it. It provides protection to a person who moves or falls towards the protective device,
- Class B – defines the system resistant to static and dynamic loads, stopping the falling people sliding off the sloping surface,
- Class C – defines a system resistant to high dynamic loads of people falling on steep surfaces. It should not only inhibit, but also absorb the force of the fall.

Prior to assembling the protective barriers, their condition must be inspected, especially the post-rails and fasteners, which should be in good condition and without visible damage. Defective elements cannot be used as safety protection. During the installation of protective railings use a safety harness and safety lines.

The main elements of protection on the side edge are the posts. Prior to installation, check their technical condition. Side guard posts are connected to the supporting structure by means of connectors (post holders), whose type depends on the stage of construction or the situation in which the protective railings are constructed:

- Standard distance between the posts should be no more than 2.0 m,
- Posts have to be inserted into the holders to a depth of at least 150 mm or until resistance is felt,

- The railing and toe boards installed, used as side protection, must always be mounted on the inner side of the post in the direction of the working surface,
- After placing the railing and toe boards, which are used as side protection lower the movable safety holders preventing the boards from being pushed up. Handrails and toe boards should be connected with an overlap only in posts appropriate for these holders,
- Boards should overlap by at least 50 cm, and their mutual overlap should be reinforced with a nail or screw in the wood.

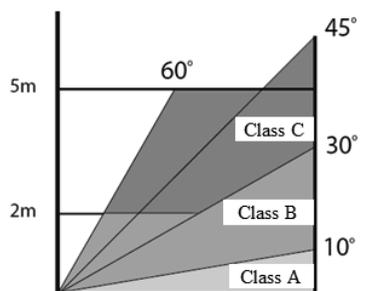
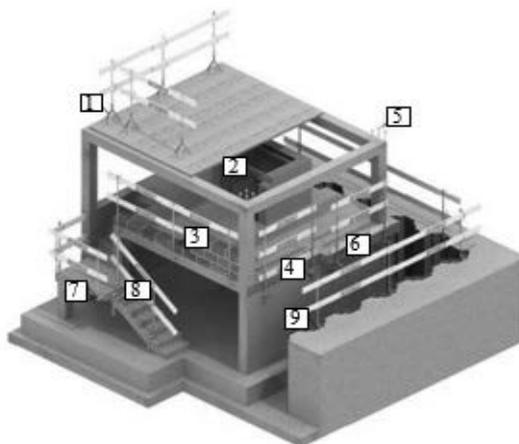


Fig. 1. Selection of appropriate SECUMAX system class depending on the height of the fall and the roof pitch [4]



- 1 Protection system for works on the edge of a slab using a holder for prefabricated elements
- 2 The holder for mounting safe protection and working platforms in lift shafts and other technological openings
- 3 Protection system for masonry work on the edge of the roof with a side post holder with a SIP socket
- 4 Protection system for formwork edges using the post holder enabling the implementation of side formwork of the floor slab
- 5 Protection system for protruding rebars
- 6 Protection system for flooring slab formwork using the adjustable post holder enabling the implementation of side formwork of the floor slab
- 7 Roof edge protection system using a screw-in holder for the side post of the of barrier
- 8 Stair edge protection system using a stair hook for the universal holder
- 9 Excavation edge protection system using a sheet pile holder

Fig. 2. SECUMAX protection system and its components (www.betomax.pl)

### 3.2. Personal protective equipment

This article presents two modern systems of personal protective equipment, to prevent falls from height, without the use of scaffolding:

#### 3.2.1. ALSIPERCHA system

ALSIPERCHA protection system (Fig. 3) is particularly useful on the edge of the formwork. It allows for activities such as the laying of planks, protective balustrades nets, formwork walls, and generally all other work required when installing formwork, where there is a risk of falling from height. It is easy to install and use, and does not require external assemblers. Its primary component is a metal structure in the shape of an inverted “L” with a length of 2.5 meters and a height of 4.3 m (this value is reduced to 3.5 m when mounted). Its weight is 80 kg and it is made of high quality steel (yield strength: 4.2–4.6 N/mm<sup>2</sup> tensile strength: 6.1–7.6 N/mm<sup>2</sup>). The entire set is moved using a crane with a special sling and embedded metal (permanent) pipes with a conical shape, which have been previously recessed into the storey posts in the process of being cast in concrete. These pipes are embedded in the interior of approximately 50% of the posts of the entire construction raised, and in no way affect its structure. Alsipercha freely rotates in the post and can easily perform a 360° turn.

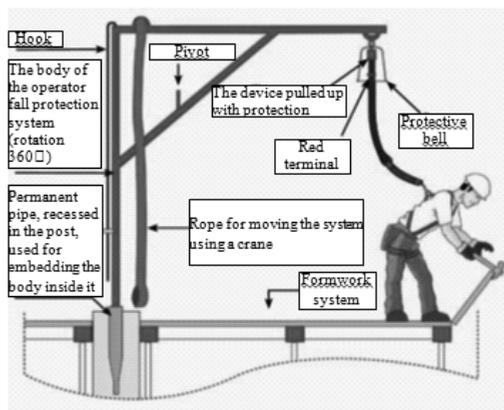


Fig. 3. ALSIPERCHA protection system and its components (www.alsina.pl)

#### 3.2.2. Inertia anchoring weights IM 200

The use of individual systems to protect against falls from height often encounters barriers due to lack of suitable elements connected with the permanent structure, to which it would be possible to connect the protective system. An element of the permanent structure useful for that purpose which should have both a suitable shape and strength – to ensure proper cooperation with the protective system.

The solution to this problem, especially for sufficiently large horizontal surfaces (e.g. horizontal ceilings or roofs of buildings) may be the use of inert anchoring weights. These

devices are rigid or flexible blocks fitted with handles for connecting the connecting/absorbing component which is a part of the protective system. Installation of an inert anchoring weight consists of laying it on the surface without additional fixings to the fixed structure. The inert anchoring weight installed this way – resting freely on the surface – replaces the permanent structure element with anchor points for the protective system (Fig. 4).

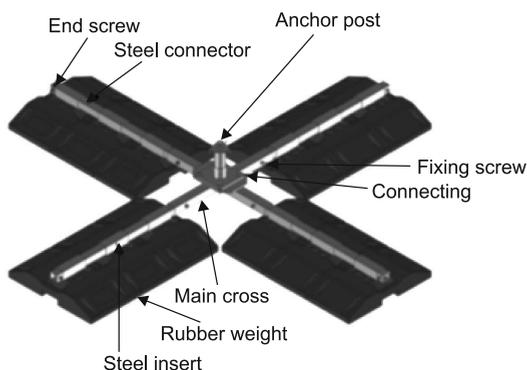


Fig. 4. Components of the anchoring weight IM 200 ([www.protekt.pl](http://www.protekt.pl))

An anchoring weight makes it possible to quickly organise a safe and secure anchor point for individual protective equipment against falls from a height, such as the edge of a flat roof. After completing the planned work, the anchoring weight can be disassembled and moved to another location or put in storage until its next use.

The modular design of the device allows it to be installed and disassembled by a person without the use of cranes, hoists or any special equipment. The weight of the individual components are also in line with provisions (the weight of a single item may not exceed 28 kg) and can therefore be moved by a worker without the use of any extra equipment.

The anchoring weights IM 200 are made of rubber and steel. All steel components are made of stainless steel or are protected against adverse weather conditions using zinc galvanising, guaranteeing their durability for up to 50 years.

The anchoring weight IM 200 may be used on surfaces such as:

- Bitumen felt,
- PVC membrane,
- Concrete.

with a slope not exceeding 5 degrees.

A large enough surface occupied by the device allows to optimally distribute the weight on the surface (e.g. roof) which minimises the influence of the load on the structure.

#### 4. Conclusions

The annual survey of negligence in ensuring safe working conditions at height indicate the recurring causes: non-use or lack of personal protective equipment, lack of supervision,

tolerating deviations from health and safety regulations, lack of or inadequate training in health and safety and the lack of, or improper collective protection measures.

Still, many contractors are cutting corners on work safety. Fortunately, large sites increasingly use modern systems and measures to prevent falls from height, which at the same time improve the efficiency of work at the site.

The experience of many EU countries indicate that only the widespread use of collective and individual protection can radically reduce the number of accidents caused by falls from height\*. The article presents modern technical measures for preventing falls from height, without the use of scaffolding, as well as the rules for their selection. These meet the safety requirements for work at heights and their advantages often outweigh erecting scaffolding, both in technical and cost-related terms. However, this does not exempt one from the obligation to wear a safety harness, for in the case of such a need, such equipment can always be used. It is essential to read the instructions on such equipment, which contain brief basic information on the principles of proper use, storage and maintenance. The effectiveness of its use, however, depends largely on the proper transfer of that information during the employee's job training, in the place of work. Obligation to transfer this knowledge rests with the person managing employees. An employer planning to carry out work at height must select the appropriate measures for the place of work, to ensure the required level of safety and health protection of workers and meet the requirements of safety and health at work.

\* A system of inspection and applying fines to construction sites which do not apply appropriate safety measures is also in place to deter this kind of behavior in some countries. (Site inspections by government safety officers in the UK for example).

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